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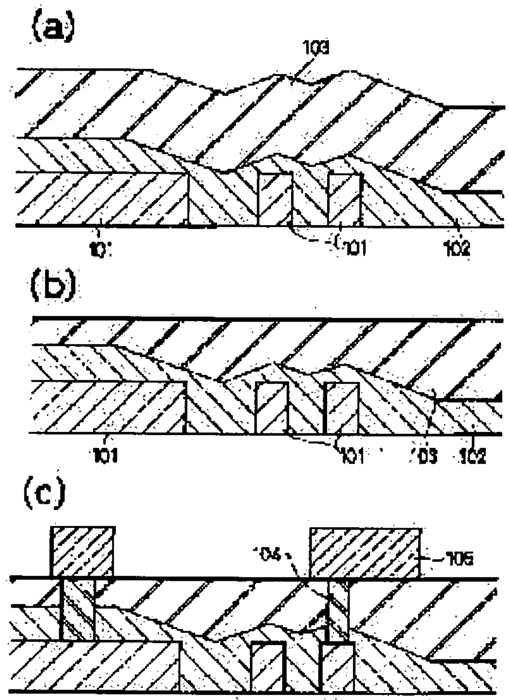
(54) SEMICONDUCTOR DEVICE AND MANUFACTURE THEREOF

(57)Abstract:
PROBLEM TO BE SOLVED: To contrive prevention of increase in interlayer the capacitance and increase in viahole resistance when high integration is obtained in a multilayer interconnection structure.
SOLUTION: This semiconductor device manufacturing method contains a process, in which the first high fluorine concentration fluorine containing plasma oxide film 102 is formed on the surface of the semiconductor substrate where the first metal wiring 101 is formed, a process in which the second fluorine-containing plasma oxide film 103 of low fluorine density, having no moisture resisting property, is formed, a process in which the second fluorine- containing plasma oxide film only is chemically and mechanically polished, a process in which a metal 104 is formed in an aperture part, and a process in which the second metal wiring 105 is formed. By conducting the above- mentioned processes or by repeating the processes, the increase in capacitance of the interlayer film and the increase of viahole resistance can be prevented even in a highly integrated state.



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CLAIMS

[Claim(s)]

[Claim 1] The semiconductor device characterized by having a silicon oxide containing the fluorine without the 2nd hygroscopicity with which it was formed on the,silicon oxide containing the 1st fluorine which fills between two or more wiring formed on the semiconductor substrate, and two or more aforementioned wiring, and the silicon oxide containing the 1st fluorine of the above, and flattening of the front face was carried out.

[Claim 2] The semiconductor device characterized by providing the following. Two or more wiring formed on the semiconductor substrate. The 2nd silicon oxide formed on the silicon oxide containing the fluorine without the 2nd hygroscopicity with which it was formed on the 1st silicon oxide formed on the aforementioned wiring, the silicon oxide containing the 1st fluorine formed on the silicon oxide of the above 1st, and the silicon oxide containing the 1st fluorine of the above, and flattening of the front face was carried out, and the silicon oxide containing the 2nd fluorine of the above.

[Claim 3] The claim 1 characterized by the specific inductive capacity of the silicon oxide containing the 1st fluorine of the above being 3.3 or less or a claim 2 is the semiconductor device of a publication respectively.

[Claim 4] The claim 1 characterized by the specific inductive capacity of the silicon oxide containing the 2nd fluorine of the above exceeding 3.3 or a claim 2 is the semiconductor device of a publication respectively.

[Claim 5] The claim 1 characterized by the fluorine concentration of the silicon oxide containing the 1st fluorine of the above being 4x1021 atoms/more than cc or a claim 2 is the semiconductor device of a publication respectively.

[Claim 6] The claim 1 characterized by the fluorine concentration of the silicon oxide containing the 2nd fluorine of the above being 4x1021 atoms/less than cc or a claim 2 is the semiconductor device of a publication respectively.

[Claim 7] The manufacture method of the semiconductor device characterized by including the process which forms wiring on a semiconductor substrate, the process which forms the silicon oxide containing the 1st fluorine, the process which forms the silicon oxide containing a fluorine without the 2nd hygroscopicity, and the process which performs and carries out flattening of the chemical mechanical polishing only to the front face of the silicon oxide containing the 2nd fluorine of the above.

[Claim 8] The manufacture method of a semiconductor device characterized by providing the following. The process which forms wiring on a semiconductor substrate. The process which forms the 1st silicon oxide. The process which forms the silicon oxide containing the 1st fluorine. The process which forms the silicon oxide containing a fluorine without the 2nd hygroscopicity, the process which performs and carries out flattening of the chemical mechanical polishing only to the front face of the silicon oxide containing the 2nd fluorine of the above, and the process which forms the 2nd silicon oxide.

[Claim 9] The claims 7 or 8 characterized by the 1st silicon oxide of the above and the 2nd silicon oxide being plasma silicon oxides are the manufacture methods of the semiconductor device a publication respectively.

[Claim 10] The claims 7 or 8 characterized by the silicon oxide containing the 1st fluorine of the above and the silicon oxide containing the 2nd fluorine being high-density plasma silicon oxides are the manufacture methods of the semiconductor device a publication respectively.

[Claim 11] The claims 7 or 8 characterized by being the high-density plasma silicon oxide in which the silicon oxide containing the 1st fluorine of the above and the silicon oxide containing the 2nd fluorine were formed continuously are the manufacture methods of the semiconductor device a publication respectively.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the semiconductor device which has an insulator layer and a layer insulation film, and its manufacture method in more detail about the manufacture method of a semiconductor device and a semiconductor device.
[0002]
[Description of the Prior Art] In recent years, the detailed-ization is progressing and the inclination can see a semiconductor integrated circuit notably in the multilayer interconnection especially in a logical circuit. if the metal interval of a multilayer interconnection becomes detailed, the capacity between the adjoining wiring becomes large, the fall of the speed of an electrical signal will be caused or a cross talk (others -- the phenomenon in which a signal affects it as a noise) will occur
[0003] There is how to form a metal layer insulation film into low specific inductive capacity as one of the cures which prevents it, and, recently, the conversion to a fluorine content plasma silicon oxide (specific inductive capacity 2.8-4.3) (henceforth a p-SiOF film) from the silicon oxide (specific inductive capacity 4.3 [about]) (henceforth p-SiO2 film) by the plasma CVD method which was being used conventionally attracts attention.
[0004] Although a p-SiOF film can be formed into low specific inductive capacity if fluorine concentration is made high, when fluorine concentration is made high not much, there is a fault that moisture resistance will deteriorate. Therefore, by the fluorine concentration of level by which moisture resistance does not deteriorate, specific inductive capacity is not reduced so much (about 3.3 specific inductive capacity).
[0005] the method of making high-density the plasma for solving the fault itself -- it is -- for example, -- '95 SSDM It is proposed by p157.
[0006] However, although fluorine concentration could be made into high concentration from the old method by this method, since a film would deteriorate if it becomes more than a certain fluorine concentration, specific inductive capacity has not fallen sharply.
[0007] Moreover, when this p-SiOF film was used as a device, flattening of the film is indispensable and the chemical mechanical-polishing method (it calls Following CMP) was used as a method of carrying out flattening of the p-SiOF film, the aforementioned damp-proof problem was a difficulty, and when CMP was used as a result, the dielectric constant had to be gathered further.
[0008] It is in fact in a difficult state to use CMP in a p-SiOF process till present as explained above.
[0009] However, it guesses from a well-known example for the time being, and two examples of an experiment which used CMP are explained.
[0010] The conventional example is an example which forms a direct p-SiOF film on metal as shown in drawing 3 . For example, SiF4, O2, and three gas of Ar are used by the 1st efficient consumer response-CVD after metal 301 formation as indicated by JP,6-333919,A, and the p-SiOF film 302 which has the 7x1021 atoms/cc fluorine concentration of specific inductive capacity 3.0 in a wafer side is formed. If CMP is performed for this film for flattening, a film will absorb moisture water and a dielectric constant will become high.
[0011] Since the combination of the fluorine into which it went so much with it being a still worse case is weak, F and H2O react, HF occurs, the corrosion of metal occurs or the phenomenon in which metal melts happens. Here, the case where fluorine concentration is lowered to 1.0x1021 atoms/about cc is explained.
[0012] A film is drawing 3 after processing by CMP. - It becomes as shown in (b). And a photoresist is applied to a film, patterning of the photoresist is carried out by eye doubling exposure, and it punctures by magnetron RIE etching which used C4 F8, CO, and Ar gas with etching technology.
[0013] Furthermore, the blanket WCVD after TiN formation is performed and beer metal 303 is formed by the flow of etchback. The 2nd metal 304, for example, the continuation spatter of AlCu-TiN, is performed after that, and a photoresist performs patterning for it. It is drawing 3 1 time or by repeating two or more times about this operation. - A multilayer interconnection is formed as shown in (c).
[0014] When all that matters here has the high fluorine concentration of a p-SiOF film, a film absorbs moisture by CMP processing of a film, and membranous fluorine concentration is that a low and a dielectric constant become high.
[0015] Moreover, the following example is SiO2 to the upper and lower sides of a p-SiOF film. By inserting a film, it is the example which holds down the hygroscopicity of a p-SiOF film. Since the SiOF film manufactured by the TEOS system (tetrapod ethoxy orthochromatic silicate : it is the same as that of the following) is indicated, JP,7-9372,B explains using it. The flow view is shown in drawing 4 .
[0016] After the 1st metal 401 formation and the 1st p-SiO2 A film 402 is formed, the raw material of the TEOS system which mixed fluorine system gas after that is used, and it is SiO2 of fluorine content. A film (p-SiOF film 403) is formed and it is the 2nd p-SiO2 after that again. The method of forming a film 404 is proposed.
[0017] Here, a plasma SiOF film is a high-density plasma CVD method advantageous to moisture resistance, and is plasma SiO2. It considered as the film high-density plasma CVD method.
[0018] Although parallel monotonous type plasma CVD was used for this method in the conventional example, it assumes

having performed the cascade screen by the high-density plasma CVD method here.
[0019] Here, it is 7x1021 atoms/cc about the fluorine concentration of a SiOF film. They are SiO2 / SiOF/SiO2 after the 1st metal 401 formation and with a high-density plasma CVD method. If continuation growth is performed, it will become a configuration as shown in drawing 4 (a) or (a)'. It is drawing 4 here. - It is drawing 4 after performing the CMP method processing when an interlayer's p-SiOF film 403 is thick, as shown in (a). - As shown in (b), the p-SiOF film 403 will become unreserved. Consequently, in order to prevent moisture absorption of a p-SiOF film from the first, it is a p-SiOF film p-SiO2 Since the p-SiOF film 403 becomes unreserved having considered as the sandwich structure by the film, a film will suck in water by CMP processing. As a result, a membranous dielectric constant will be gathered.
[0020] Moreover, since it is not as mentioned above, when the p-SiOF film 403 is made thin like drawing 4 -(a)' and the 2nd SiO2 film 404 is thickened, the p-SiOF film 403 does not become unreserved like drawing 4 -(b)' after CMP processing. However, it is p-SiO2 also between the metal layers which adjoin now. A film enters and the fault that a dielectric constant will increase occurs.
[0021] After that, it continues like the above-mentioned example 1 of an experiment with the beer hall formation -> beer metal formation -> 2nd metal formation, and, as for a configuration, a multilayer interconnection is formed like drawing 4 (c) and (c)', respectively.
[0022] the relation between the fluorine content in the silicon oxide containing the fluorine at the time of using high-density plasma CVD for drawing 5 , and specific inductive capacity -- moreover, the relation between the fluorine content in the silicon oxide containing the fluorine at the time of using high-density plasma CVD for drawing 6 and hygroscopicity is shown (The collection of the 1995 semiconductor-integrated-circuit symposium drafts the 45th page) These drawings show an example of the fluorine content of a silicon oxide, and a dielectric constant and an inclination with hygroscopicity, and although a numeric value may change a little with equipment and fluorine content and these properties show the same rate, they show the inclination for the fluorine content of a silicon oxide to influence a dielectric constant and hygroscopicity.
[0023] If CMP processing of the p-SiOF film of low specific inductive capacity [trouble / 1st / examples / 1 and 2 / of an experiment] is carried out, a dielectric constant will become high or a beer hall will become unusual. Furthermore, a metallic corrosion occurs. The reason will absorb moisture, if p-SiOF of low specific inductive capacity is soaked in water, a dielectric constant increases, and it becomes a beer hall resistivity anomaly. Moreover, the water and the fluorine which absorbed moisture react and metaled corrosion occurs.
[0024] The 2nd trouble is SiO2 / SiOF/SiO2 so that the 1st trouble may not occur in the example 2 of an experiment. If the middle p-SiOF layer of structure is made thin, the dielectric constant between metal layers will increase. The reason is p-SiO2 occupied between metal layers. It is because a rate increases.
[0025]
[The technical problem which should solve invention] the purpose of this invention -- a semiconductor integrated circuit -- it aims at the improvement in reliability of increase prevention (realization of the reduction in a dielectric constant) of the layer mesenteriolum capacity in the case of high integration, increase prevention of beer hall resistance, etc. especially in multilayer-interconnection structure
[0026]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, the invention-in-this-application person inquired wholeheartedly, and reached this invention. That is, this invention includes the following embodiments.
[0027] (1) It is offering the semiconductor device characterized by having a silicon oxide containing the fluorine without the 2nd hygroscopicity with which it was formed on the silicon oxide containing the 1st fluorine which fills between two or more wiring formed on the semiconductor substrate, and two or more aforementioned wiring, and the silicon oxide containing the 1st fluorine of the above, and flattening of the front face was carried out.
[0028] (2) It was formed on two or more wiring formed on the semiconductor substrate, the 1st silicon oxide formed on the aforementioned wiring, the silicon oxide containing the 1st fluorine formed on the silicon oxide of the above 1st, and the silicon oxide containing the 1st fluorine of the above, and flattening of the front face was carried out. The semiconductor device characterized by having a silicon oxide containing a fluorine without the 2nd hygroscopicity, and the 2nd silicon oxide formed on the silicon oxide containing the 2nd fluorine of the above.
[0029] (3) (1) characterized by the specific inductive capacity of the silicon oxide containing the 1st fluorine of the above being 3.3 or less or (2) are the semiconductor device of a publication respectively.
[0030] (4) (1) characterized by the specific inductive capacity of the silicon oxide containing the 2nd fluorine of the above exceeding 3.3 or (2) are the semiconductor device of a publication respectively.
[0031] (5) (1) characterized by the fluorine concentration of the silicon oxide containing the 1st fluorine of the above being 4x1021 atoms/more than cc or (2) are the semiconductor device of a publication respectively.
[0032] (6) (1) characterized by the fluorine concentration of the silicon oxide containing the 2nd fluorine of the above being 4x1021 atoms/less than cc or (2) are the semiconductor device of a publication respectively.
[0033] (7) The manufacture method of the semiconductor device characterized by including the process which forms wiring on a semiconductor substrate, the process which forms the silicon oxide containing the 1st fluorine, the process which forms the silicon oxide containing a fluorine without the 2nd hygroscopicity, and the process which performs and carries out flattening of the chemical mechanical polishing only to the front face of the silicon oxide containing the 2nd fluorine of the above.
[0034] (8) The manufacture method of the semiconductor device characterized by to include the process which forms wiring on a semiconductor substrate, the process which form the 1st silicon oxide, the process which form the silicon oxide containing the 1st fluorine, the process which form the silicon oxide containing a fluorine without the 2nd hygroscopicity, and the process which performs and carries out flattening of the chemical mechanical polishing only to the front face of the silicon oxide containing the 2nd fluorine of the above and the process which forms the 2nd silicon oxide.
[0035] (9) (7) characterized by the 1st silicon oxide of the above and the 2nd silicon oxide being plasma silicon oxides or (8) are the manufacture method of the semiconductor device a publication respectively.
[0036] (10) (7) characterized by the silicon oxide containing the silicon oxide containing the 1st fluorine of the above and the 2nd fluorine being a high-density plasma silicon oxide or (8) are the manufacture method of the semiconductor device a

publication respectively.

[0037] (11) (7) characterized by being the high-density plasma silicon oxide in which the silicon oxide containing the 1st fluorine of the above and the silicon oxide containing the 2nd fluorine were formed continuously, or (8) are the manufacture method of the semiconductor device a publication respectively.

[0038]

[Embodiments of the Invention] The manufacture method of the semiconductor device of this invention, and a semiconductor device The process which forms the fluorine content plasma silicon oxide of the 1st high fluorine concentration in the semiconductor substrate front face in which the 1st metal wiring was formed, and forms the fluorine content plasma silicon oxide of the 2nd low fluorine concentration continuously, It is characterized by 1 time or repeating two or more times including the process which performs chemical mechanical polishing only to the 2nd fluorine content plasma silicon oxide, the process which punctures in a desired position and the process which forms a metal in the aperture of **, and the process which forms the 2nd metal wiring (drawing 1). Moreover, depending on the kind of plasma SiOF film, it is expected if the adhesion in an interface is bad if based on a metal kind and, that a reaction occurs.

[0039] In this case, the process which forms the plasma silicon oxide after [1st] the 1st metal wiring formation, forms the p-SiOF film of the above 1st, forms the 2nd p-SiOF, and performs CMP processing only to the 2nd p-SiOF film after that, More furthermore than a it top, it is characterized by 1 time or repeating two or more times including the process which forms the 2nd p-SiO2, the process which punctures in a desired position, the process which forms a metal in the aperture, and the process which forms the 2nd metal wiring (drawing 2).

[0040] In order that this invention may reduce the capacity between wiring, although it embeds at least between wiring by the fluorine content silicon oxide at least with specific inductive capacity smaller than a silicon oxide and there is no hygroscopicity in the upper surface further, since the fluorine content silicon oxide with high specific inductive capacity is formed, even if it carries out flattening using CMP, increase of the specific inductive capacity by moisture absorption does not take place, either. Moreover, when creating the beer hall process of a back process, the poor beer hall resistance increase which does not almost have moisture absorption by the upper fluorine content silicon oxide does not occur.

[0041]

[Example] Next, the example of this invention is explained in detail with reference to a drawing.

[0042] The 1st example of this invention is explained with reference to drawing 1 . Drawing 1 - As shown in (a), the 1st p-SiOF film 102 with a thickness of 5000A was formed in bias efficient consumer response-CVD on the 1st metal 101, and the 2nd p-SiOF film 103 with a thickness of 10000A was formed further. The 2nd p-SiOF film 103 is 4.0x1021 atoms/cc less than] fluorine concentration, and the 1st lower layer p-SiOF film 102 had 4.0x021 atoms/cc fluorine concentration higher than the 1st p-SiOF film in the wafer side here. This plasma SiOF/SiO2 Although to grow continuously is laying-under-the-ground nature] better, a laminated structure may grow separately, when the problem on an operating ratio has a high-density plasma CVD method and there is ** etc. It is drawing 1 only about the 2nd p-SiOF film in CMP processing after that. - As shown in (b), about 4000A is ground. By the fluorine concentration of this 2nd plasma SiOF, it is checked by our experiment that it is the film which does not absorb moisture. Then, the photoresist was applied to this film, eye doubling and exposure were performed, patterning of the photoresist was carried out, and the two-layer film of p-SiOF was punctured by magnetron RIE etching which used C4 F8, CO, and Ar gas with etching technology.

[0043] Furthermore, as a barrier layer, by the blanket WCVD method after TiN formation, the tungsten was formed, etchback was performed and beer metal 104 was formed.

[0044] Then, the 2nd metal 105, for example, the continuation spatter of AlCu-TiN, was performed, and the photoresist performed patterning for it. It is drawing 1 about multilayer wiring 1 time or by repeating two or more times in this. - It formed, as shown in (c).

[0045] By the above process flow, capacity between metal layers could be made small, and the film could carry out flattening, and the multilayer interconnection became possible. In addition, the specific inductive capacity of the silicon oxide in which the specific inductive capacity of the silicon oxide containing the 1st fluorine in this example contains 3.0 and the 2nd fluorine was 3.5.

[0046] Furthermore, the 2nd example is explained in detail with reference to a drawing 2. Although the direct p-SiOF film was formed on metal in the 1st example, it is good to use the 2nd example shown below at the times, like the reaction of the case where the adhesion of metal and a p-SiOF film is bad, and metal and p-SiOF occurs according to the kind of metal, or the kind of p-SiOF film.

[0047] Drawing 2 - As shown in (a), it is the 1st p-SiO2 at bias efficient consumer response-CVD on the 1st metal 201. 1000A in thickness, 4000A, and 10000A growth were performed for a film 202, the 1st p-SiOF film 203, and the 2nd p-SiOF film 204, for example, respectively.

[0048] The range of the fluorine concentration of the 2nd p-SiOF film 204 is 4.0x1021 atoms/less than cc, and the fluorine concentration of the 1st lower layer p-SiOF film 203 had a 4.0x1021 atoms/cc [more than] portion in the one section or all within a wafer side.

[0049] About 4000A polish in thickness was performed [CMP processing] only for the 2nd plasma SiOF film 204 after that. By the fluorine concentration of this 2nd plasma SiOF film, it is checked by our experiment that it is the film which does not absorb moisture.

[0050] It is the 2nd p-SiO2 on it. The film 205 was grown up about 2000A in thickness (drawing 2 -(b)).

[0051] Then, they are SiO2 / SiOF two-layer / SiO2 by magnetron RIE etching which applied the photoresist and used C4 F8, CO, and Ar gas by eye doubling exposure. A cascade screen is punctured. Still like the 1st example, BURANKETO W-CVD after TiN formation was formed, etchback was performed, and the beer metal 206 was formed.

[0052] Then, the 2nd metal 207, for example, the continuation spatter of AlCu-TiN, was performed, and the photoresist performed patterning for it. It is drawing 2 about a multilayer interconnection 1 time or by repeating two or more times in this. - It formed, as shown in (c).

[0053] Although the above is the 2nd example, and through, the 1st metal, and the 2nd metal are using the continuation spatter of AlCu-TiN for the 1st and the 2nd example, as an additive to aluminum, Si, Pd, and Ti besides Cu are sufficient. Moreover, Cu and Ag are sufficient even if it is not aluminum. Although TiN is furthermore used for acid resisting, Ti, TiW,

Cr, and Si are sufficient. Moreover, as a beer metal, although W-CVD/TiN is used, Ag, Cu, and aluminum are sufficient instead of W of beer. Moreover, as a barrier metal, the monolayer of Ti, TiW, Si, and Cr or two or more kinds of its combination is sufficient. The type of gas which furthermore manufactures a p-SiOF film SiH4+O2+Ar+CF4 and SiH4 + O2+Ar+C two F6 and SiH4+O2 + Ar+NF3 and SiF4+O2+Ar -- SiF4 + SiH4+O2+Ar and TEOS+O2 + Ar+CF4 and TEOS+O2+Ar+C2 F6, TEOS+O2+Ar+NF3, TEFS(FURORO triethoxysilane : it is the same as that of the following)+O2+Ar, TEFS+SiH4+O2+Ar, and TEOS+SiF4+Ar+O2 What extracted Ar from either or the inside of this inside may be used. You may replace with the type of gas which may set to Xe instead of Ar for the reason on a laying-under-the-ground disposition, and is used for a two-layer eye with the 1st layer. For example, they are SiF4+Ar+O2 and a two-layer eye about the 1st layer SiF4+SiH4+Ar+O2 You may use.

[0054] Moreover, although p-SiOF is performed by one of ICP-CVD (the bias efficient consumer response-CVD which used the parallel monotonous CVD which used the frequency of 13.56MHz, 13.56MHz, the parallel monotonous CVD using 2 400kHz cycles and a 2.45GHz RF, and 13.56MHz bias, 2.45GHz, and 13.56MHz), or the Helicon CVD, its high-density plasma CVD methods, such as bias efficient consumer response-CVD, ICP-CVD, and the Helicon CVD, are better.

[0055] In order to abolish moisture absorption of the SiOF film after CMP completely furthermore, you may add 300-450-degree C heat treatment after CMP. the atmosphere in the case of this processing -- the inside of O2, N2, H2, and a vacuum, and the inside of Air and helium -- any one -- or two or more sets may be seen and doubling is sufficient

[0056] Moreover, SiO2 Although SiOF thickness was set up for convenience in order to show an example, the combination of thickness which is different if it sets up so that only the 2nd SiOF may be processed by CMP processing is sufficient.

[0057] Moreover, the 2nd p-SiOF film may be made into concentration with a fluorine concentration of 4.0x1021 atoms/cc less than], and you may make it the multilayer which is different in fluorine concentration in the range. Moreover, since there is a merit of this invention if the 1 section also of 1st p-SiOF layer also exists in a wafer even if the place whose fluorine concentration is 4.0x1021 atoms/more than cc is not the whole wafer surface, such an embodiment is also included in the range of the invention in this application. Moreover, although the 2nd p-SiOF film was limited with 4.0x1021 atoms/cc [less than] fluorine concentration, it can restrict to the field to which the 2nd p-SiOF film is all removed at CMP processing, and the film of the fluorine concentration beyond it can also be used.

[0058] the specific inductive capacity of the silicon oxide which contains the 1st fluorine by the method of this invention -- 3.3 or less -- desirable -- 3.2 or less -- it is -- the minimum -- 2.8 -- it is 2.9 preferably moreover, the specific inductive capacity of the silicon oxide containing the 2nd fluorine -- 3.3 -- exceeding -- desirable -- 3.4 or more -- it is -- the upper limit -- 4.1 -- it is 3.9 preferably

[0059] Moreover, the fluorine concentration of the silicon oxide which contains the 1st fluorine by the method of this invention is 4.0x1021 atoms/more than cc, it is a 6.0x1021 atoms/cc [more than] ratio preferably, and the upper limit is 8.0x1021 atoms/cc preferably 1.0x1022 atoms/cc.

[0060] Moreover, the fluorine concentration of the silicon oxide containing the 2nd fluorine is 2.0x1021 atoms/less than cc preferably 4.0x1021 atoms/less than cc, and the minimum is 1.0x1020 atoms/cc.

[0061] In addition, the specific inductive capacity of the silicon oxide in which the specific inductive capacity of the silicon oxide containing the 1st fluorine in this example contains 3.0 and the 2nd fluorine was 3.5.

[0062] Furthermore, in the after [blanket WCVD] examples 1 and 2, although etchback was performed, you may perform metal CMP. Moreover, you may carry out by selection W-CVD. Moreover, it is O2 because of a wettability improvement before CMP of a p-SiOF film, and CMP of the above-mentioned metal. You may perform plasma.

[0063] Moreover, p-SiOF/p-SiO2 of the 2nd example It is better for a laminating to carry out by continuation growth for a laying-under-the-ground nature improvement especially in the case of a bias high-density plasma CVD method.

[0064]

[Effect of the Invention] Book

[0065] since the 1st effect has the moisture resistance of a p-SiOF film itself even if it carries out CMP processing of the p-SiOF film -- low -- the dielectric constant metal layer mesenteriolum can be built Since the reason makes the upper layer which carries out a p-SiOF layer to more than two-layer, and is exposed to CMP processing 4.0x1021 atoms/cc [less than] fluorine concentration, it is because there is moisture resistance.

[0066] The 2nd effect is SiO2 / SiOF/SiO2. Even if it makes it structure, a comparatively small capacity between metal layers is obtained. The reason is SiOF two-layer / SiO2. After forming structure, CMP processing is performed, and it is SiO2 after that. Since it forms, it is SiO2 of the upper layer. It is for not going into the layer mesenteriolum between the metal to which the layer is located in a line in the direction of X.

[Translation done.]

TECHNICAL FIELD

[The technical field to which invention belongs] this invention relates to the semiconductor device which has an insulator layer and a layer insulation film, and its manufacture method in more detail about the manufacture method of a semiconductor device and a semiconductor device.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflec
2.**** shows the word which can not be translated.
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PRIOR ART

[Description of the Prior Art] In recent years, the detailed-ization is progressing and th integrated circuit notably in the multilayer interconnection especially in a logical circu interconnection becomes detailed, the capacity between the adjoining wiring becomes electrical signal will be caused or a cross talk (others -- the phenomenon in which a sign
[0003] There is how to form a metal layer insulation film into low specific inductive ca prevents it, and, recently, the conversion to a fluorine content plasma silicon oxide (spec (henceforth a p-SiOF film) from the silicon oxide (specific inductive capacity 4.3 [abou plasma CVD method which was being used conventionally attracts attention.
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[0005] the method of making high-density the plasma for solving the fault itself -- it is -- proposed by p157.
[0006] However, although fluorine concentration could be made into high concentration since a film would deteriorate if it becomes more than a certain fluorine concentration, spe fallen sharply.
[0007] Moreover, when this p-SiOF film was used as a device, flattening of the film is indis mechanical-polishing method (it calls Following CMP) was used as a method of carrying o the aforementioned damp-proof problem was a difficulty, and when CMP was used as a res be gathered further.
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[0009] However, it guesses from a well-known example for the time being, and two example CMP are explained.
[0010] The conventional example is an example which forms a direct p-SiOF film on metal example, SiF4, O2, and three gas of Ar are used by the 1st efficient consumer response-CVD indicated by JP,6-333919,A, and the p-SiOF film 302 which has the 7x1021 atoms/cc fluorine inductive capacity 3.0 in a wafer side is formed. If CMP is performed for this film for flattenin water and a dielectric constant will become high.
[0011] Since the combination of the fluorine into which it went so much with it being a still wa react, HF occurs, the corrosion of metal occurs or the phenomenon in which metal melts happen fluorine concentration is lowered to 1.0x1021 atoms/about cc is explained.
[0012] A film is drawing 3 after processing by CMP. - It becomes as shown in (b). And a photor patterning of the photoresist is carried out by eye doubling exposure, and it punctures by magne C4 F8, CO, and Ar gas with etching technology.
[0013] Furthermore, the blanket WCVD after TiN formation is performed and beer metal 303 is etchback. The 2nd metal 304, for example, the continuation spatter of AlCu-TiN, is performed an performs patterning for it. It is drawing 3 1 time or by repeating two or more times about this ope interconnection is formed as shown in (c).
[0014] When all that matters here has the high fluorine concentration of a p-SiOF film, a film abso processing of a film, and membranous fluorine concentration is that a low and a dielectric constan
[0015] Moreover, the following example is SiO2 to the upper and lower sides of a p-SiOF film. B example which holds down the hygroscopicity of a p-SiOF film. Since the SiOF film manufacture (tetrapod ethoxy orthochromatic silicate : it is the same as that of the following) is indicated, JP,7- The flow view is shown in drawing 4 .
[0016] After the 1st metal 401 formation and the 1st p-SiO2 A film 402 is formed, the raw material which mixed fluorine system gas after that is used, and it is SiO2 of fluorine content. A film (p-SiOF it is the 2nd p-SiO2 after that again. The method of forming a film 404 is proposed.
[0017] Here, a plasma SiOF film is a high-density plasma CVD method advantageous to moisture res SiO2. It considered as the film high-density plasma CVD method.
[0018] Although parallel monotonous type plasma CVD was used for this method in the conventiona having performed the cascade screen by the high-density plasma CVD method here.
[0019] Here, it is 7x1021 atoms/cc about the fluorine concentration of a SiOF film. They are SiO2 / Si metal 401 formation and with a high-density plasma CVD method. If continuation growth is performe configuration as shown in drawing 4 (a) or (a)'. It is drawing 4 here. - It is drawing 4 after performing th processing when an interlayer's p-SiOF film 403 is thick, as shown in (a). - As shown in (b), the p-SiOF become unreserved. Consequently, in order to prevent moisture absorption of a p-SiOF film from the ti

p-SiO2 Since the p-SiOF film 403 becomes unreserved having considered as the sandwich structure by the film, a film will suck in water by CMP processing. As a result, a membranous dielectric constant will be gathered.
[0020] Moreover, since it is not as mentioned above, when the p-SiOF film 403 is made thin like drawing 4 -(a)' and the 2nd SiO2 film 404 is thickened, the p-SiOF film 403 does not become unreserved like drawing 4 -(b)' after CMP processing. However, it is p-SiO2 also between the metal layers which adjoin now. A film enters and the fault that a dielectric constant will increase occurs.
[0021] After that, it continues like the above-mentioned example 1 of an experiment with the beer hall formation -> beer metal formation -> 2nd metal formation, and, as for a configuration, a multilayer interconnection is formed like drawing 4 (c) and (c)', respectively.
[0022] the relation between the fluorine content in the silicon oxide containing the fluorine at the time of using high-density plasma CVD for drawing 5 , and specific inductive capacity -- moreover, the relation between the fluorine content in the silicon oxide containing the fluorine at the time of using high-density plasma CVD for drawing 6 and hygroscopicity is shown (The collection of the 1995 semiconductor-integrated-circuit symposium drafts the 45th page) These drawings show an example of the fluorine content of a silicon oxide, and a dielectric constant and an inclination with hygroscopicity, and although a numeric value may change a little with equipment and fluorine content and these properties show the same rate, they show the inclination for the fluorine content of a silicon oxide to influence a dielectric constant and hygroscopicity.
[0023] If CMP processing of the p-SiOF film of low specific inductive capacity [trouble / 1st / examples / 1 and 2 / of an experiment] is carried out, a dielectric constant will become high or a beer hall will become unusual. Furthermore, a metallic corrosion occurs. The reason will absorb moisture, if p-SiOF of low specific inductive capacity is soaked in water, a dielectric constant increases, and it becomes a beer hall resistivity anomaly. Moreover, the water and the fluorine which absorbed moisture react and metaled corrosion occurs.
[0024] The 2nd trouble is SiO2 / SiOF/SiO2 so that the 1st trouble may not occur in the example 2 of an experiment. If the middle p-SiOF layer of structure is made thin, the dielectric constant between metal layers will increase. The reason is p-SiO2 occupied between metal layers. It is because a rate increases.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] Book
[0065] since the 1st effect has the moisture resistance of a p-SiOF film itself even if it carries out CMP processing of the p-SiOF film -- low -- dielectric constant metal ****** can be built Since the reason makes the upper layer which carries out a p-SiOF layer to more than two-layer, and is exposed to CMP processing 4.0x1021 atoms/cc [less than] fluorine concentration, it is because there is moisture resistance.
[0066] The 2nd effect is SiO2 / SiOF/SiO2. Even if it makes it structure, a comparatively small capacity between metal layers is obtained. The reason is SiOF two-layer / SiO2. After forming structure, CMP processing is performed, and it is SiO2 after that. Since it forms, it is SiO2 of the upper layer. It is for not going into ****** between the metal to which the layer is located in a line in the direction of X.

[Translation done.]

TECHNICAL PROBLEM

[The technical problem which should solve invention] the purpose of this invention -- a semiconductor integrated circuit -- it aims at the improvement in reliability of increase prevention (realization of the reduction in a dielectric constant) of the membrane capacitance between layers in the case of high integration, increase prevention of beer hall resistance, etc. especially in multilayer-interconnection structure

[Translation done.]

MEANS

[Means for Solving the Problem] In order to attain the above-mentioned purpose, the invention-in-this-application person inquired wholeheartedly, and reached this invention. That is, this invention includes the following embodiments.
[0027] (1) It is offering the semiconductor device characterized by having a silicon oxide containing the fluorine without the 2nd hygroscopicity with which it was formed on the silicon oxide containing the 1st fluorine which fills between two or more wiring formed on the semiconductor substrate, and two or more aforementioned wiring, and the silicon oxide containing the 1st fluorine of the above, and flattening of the front face was carried out.
[0028] (2) It was formed on two or more wiring formed on the semiconductor substrate, the 1st silicon oxide formed on the aforementioned wiring, the silicon oxide containing the 1st fluorine formed on the silicon oxide of the above 1st, and the silicon oxide containing the 1st fluorine of the above, and flattening of the front face was carried out. The semiconductor device characterized by having a silicon oxide containing a fluorine without the 2nd hygroscopicity, and the 2nd silicon oxide formed on the silicon oxide containing the 2nd fluorine of the above.
[0029] (3) (1) characterized by the specific inductive capacity of the silicon oxide containing the 1st fluorine of the above being 3.3 or less or (2) are the semiconductor device of a publication respectively.
[0030] (4) (1) characterized by the specific inductive capacity of the silicon oxide containing the 2nd fluorine of the above exceeding 3.3 or (2) are the semiconductor device of a publication respectively.
[0031] (5) (1) characterized by the fluorine concentration of the silicon oxide containing the 1st fluorine of the above being 4x1021 atoms/more than cc or (2) are the semiconductor device of a publication respectively.
[0032] (6) (1) characterized by the fluorine concentration of the silicon oxide containing the 2nd fluorine of the above being 4x1021 atoms/less than cc or (2) are the semiconductor device of a publication respectively.
[0033] (7) The manufacture method of the semiconductor device characterized by including the process which forms wiring on a semiconductor substrate, the process which forms the silicon oxide containing the 1st fluorine, the process which forms the silicon oxide containing a fluorine without the 2nd hygroscopicity, and the process which performs and carries out flattening of the chemical mechanical polishing only to the front face of the silicon oxide containing the 2nd fluorine of the above.
[0034] (8) The manufacture method of the semiconductor device characterized by to include the process which forms wiring on a semiconductor substrate, the process which form the 1st silicon oxide, the process which form the silicon oxide containing the 1st fluorine, the process which form the silicon oxide containing a fluorine without the 2nd hygroscopicity, and the process which performs and carries out flattening of the chemical mechanical polishing only to the front face of the silicon oxide containing the 2nd fluorine of the above and the process which forms the 2nd silicon oxide.
[0035] (9) (7) characterized by the 1st silicon oxide of the above and the 2nd silicon oxide being plasma silicon oxides or (8) are the manufacture method of the semiconductor device a publication respectively.
[0036] (10) (7) characterized by the silicon oxide containing the silicon oxide containing the 1st fluorine of the above and the 2nd fluorine being a high-density plasma silicon oxide or (8) are the manufacture method of the semiconductor device a publication respectively.
[0037] (11) (7) characterized by being the high-density plasma silicon oxide in which the silicon oxide containing the 1st fluorine of the above and the silicon oxide containing the 2nd fluorine were formed continuously, or (8) are the manufacture method of the semiconductor device a publication respectively.
[0038]
[Embodiments of the Invention] The manufacture method of the semiconductor device of this invention, and a semiconductor device The process which forms the fluorine content plasma silicon oxide of the 1st high fluorine concentration in the semiconductor substrate front face in which the 1st metal wiring was formed, and forms the fluorine content plasma silicon oxide of the 2nd low fluorine concentration continuously, It is characterized by 1 time or repeating two or more times including the process which performs chemical mechanical polishing only to the 2nd fluorine content plasma silicon oxide, the process which punctures in a desired position and the process which forms a metal in the aperture of **, and the process which forms the 2nd metal wiring (drawing 1). Moreover, depending on the kind of plasma SiOF film, it is expected if the adhesion in an interface is bad if based on a metal kind and, that a reaction occurs.
[0039] In this case, the process which forms the plasma silicon oxide after [1st] the 1st metal wiring formation, forms the p-SiOF film of the above 1st, forms the 2nd p-SiOF, and performs CMP processing only to the 2nd p-SiOF film after that, More furthermore than a it top, it is characterized by 1 time or repeating two or more times including the process which forms the 2nd p-SiO2, the process which punctures in a desired position, the process which forms a metal in the aperture, and the process which forms the 2nd metal wiring (drawing 2).
[0040] In order that this invention may reduce the capacity between wiring, although it embeds at least between wiring by the fluorine content silicon oxide at least with specific inductive capacity smaller than a silicon oxide and there is no hygroscopicity in the upper surface further, since the fluorine content silicon oxide with high specific inductive capacity is formed, even if it carries out flattening using CMP, increase of the specific inductive capacity by moisture absorption does not take place, either. Moreover, when creating the beer hall process of a back process, the poor beer hall resistance increase which does not almost have moisture absorption by the upper fluorine content silicon oxide does not occur.

[Translation done.]

EXAMPLE

[Example] Next, the example of this invention is explained in detail with reference to a drawing.
[0042] The 1st example of this invention is explained with reference to drawing 1 . Drawing 1 - As shown in (a), the 1st p-SiOF film 102 with a thickness of 5000A was formed in bias efficient consumer response-CVD on the 1st metal 101, and the 2nd p-SiOF film 103 with a thickness of 10000A was formed further. The 2nd p-SiOF film 103 is 4.0x1021 atoms/cc less than] fluorine concentration, and the 1st lower layer p-SiOF film 102 had 4.0x021 atoms/cc fluorine concentration higher than the 1st p-SiOF film in the wafer side here. This plasma SiOF/SiO2 Although to grow continuously is laying-under-the-ground nature] better, a laminated structure may grow separately, when the problem on an operating ratio has a high-density plasma CVD method and there is ** etc. It is drawing 1 only about the 2nd p-SiOF film in CMP processing after that. - As shown in (b), about 4000A is ground. By the fluorine concentration of this 2nd plasma SiOF, it is checked by our experiment that it is the film which does not absorb moisture. Then, the photoresist was applied to this film, eye doubling and exposure were performed, patterning of the photoresist was carried out, and the two-layer film of p-SiOF was punctured by magnetron RIE etching which used C4 F8, CO, and Ar gas with etching technology.
[0043] Furthermore, as a barrier layer, by the blanket WCVD method after TiN formation, the tungsten was formed, etchback was performed and beer metal 104 was formed.
[0044] Then, the 2nd metal 105, for example, the continuation spatter of AlCu-TiN, was performed, and the photoresist performed patterning for it. It is drawing 1 about multilayer wiring 1 time or by repeating two or more times in this. - It formed, as shown in (c).
[0045] By the above process flow, capacity between metal layers could be made small, and the film could carry out flattening, and the multilayer interconnection became possible. In addition, the specific inductive capacity of the silicon oxide in which the specific inductive capacity of the silicon oxide containing the 1st fluorine in this example contains 3.0 and the 2nd fluorine was 3.5.
[0046] Furthermore, the 2nd example is explained in detail with reference to a drawing 2. Although the direct p-SiOF film was formed on metal in the 1st example, it is good to use the 2nd example shown below at the times, like the reaction of the case where the adhesion of metal and a p-SiOF film is bad, and metal and p-SiOF occurs according to the kind of metal, or the kind of p-SiOF film.
[0047] Drawing 2 - As shown in (a), it is the 1st p-SiO2 at bias efficient consumer response-CVD on the 1st metal 201. 1000A in thickness, 4000A, and 10000A growth were performed for a film 202, the 1st p-SiOF film 203, and the 2nd p-SiOF film 204, for example, respectively.
[0048] The range of the fluorine concentration of the 2nd p-SiOF film 204 is 4.0x1021 atoms/less than cc, and the fluorine concentration of the 1st lower layer p-SiOF film 203 had a 4.0x1021 atoms/cc [more than] portion in the one section or all within a wafer side.
[0049] About 4000A polish in thickness was performed [CMP processing] only for the 2nd plasma SiOF film 204 after that. By the fluorine concentration of this 2nd plasma SiOF film, it is checked by our experiment that it is the film which does not absorb moisture.
[0050] It is the 2nd p-SiO2 on it. The film 205 was grown up about 2000A in thickness (drawing 2 -(b)).
[0051] Then, they are SiO2 / SiOF two-layer / SiO2 by magnetron RIE etching which applied the photoresist and used C4 F8, CO, and Ar gas by eye doubling exposure. A cascade screen is punctured. Still like the 1st example, BURANKETO W-CVD after TiN formation was formed, etchback was performed, and the beer metal 206 was formed.
[0052] Then, the 2nd metal 207, for example, the continuation spatter of AlCu-TiN, was performed, and the photoresist performed patterning for it. It is drawing 2 about a multilayer interconnection 1 time or by repeating two or more times in this. - It formed, as shown in (c).
[0053] Although the above is the 2nd example, and through, the 1st metal, and the 2nd metal are using the continuation spatter of AlCu-TiN for the 1st and the 2nd example, as an additive to aluminum, Si, Pd, and Ti besides Cu are sufficient. Moreover, Cu and Ag are sufficient even if it is not aluminum. Although TiN is furthermore used for acid resisting, Ti, TiW, Cr, and Si are sufficient. Moreover, as a beer metal, although W-CVD/TiN is used, Ag, Cu, and aluminum are sufficient instead of W of beer. Moreover, as a barrier metal, the monolayer of Ti, TiW, Si, and Cr or two or more kinds of its combination is sufficient. The type of gas which furthermore manufactures a p-SiOF film SiH4+O2+Ar+CF4 and SiH4 + O2+Ar+C two F6 and SiH4+O2 + Ar+NF3 and SiF4+O2+Ar -- SiF4 + SiH4+O2+Ar and TEOS+O2 + Ar+CF4 and TEOS+O2+Ar+C2 F6, TEOS+O2+Ar+NF3, TEFS(FURORO triethoxysilane : it is the same as that of the following)+O2+Ar, TEFS+SiH4+O2+Ar, and TEOS+SiF4+Ar+O2 What extracted Ar from either or the inside of this inside may be used. You may replace with the type of gas which may set to Xe instead of Ar for the reason on a laying-under-the-ground disposition, and is used for a two-layer eye with the 1st layer. For example, they are SiF4+Ar+O2 and a two-layer eye about the 1st layer SiF4+SiH4+Ar+O2 You may use.
[0054] Moreover, although p-SiOF is performed by one of ICP-CVD (the bias efficient consumer response-CVD which used the parallel monotonous CVD which used the frequency of 13.56MHz, 13.56MHz, the parallel monotonous CVD using 2 400kHz cycles and a 2.45GHz RF, and 13.56MHz bias, 2.45GHz, and 13.56MHz), or the Helicon CVD, its high-density plasma CVD methods, such as bias efficient consumer response-CVD, ICP-CVD, and the Helicon CVD, are better.

[0055] In order to abolish moisture absorption of the SiOF film after CMP completely furthermore, you may add 300-450-degree C heat treatment after CMP. the atmosphere in the case of this processing -- the inside of O2, N2, H2, and a vacuum, and the inside of Air and helium -- any one -- or two or more sets may be seen and doubling is sufficient
[0056] Moreover, SiO2 Although SiOF thickness was set up for convenience in order to show an example, the combination of thickness which is different if it sets up so that only the 2nd SiOF may be processed by CMP processing is sufficient.
[0057] Moreover, the 2nd p-SiOF film may be made into concentration with a fluorine concentration of 4.0x1021 atoms/cc [less than], and you may make it the multilayer which is different in fluorine concentration in the range. Moreover, since there is a merit of this invention if the 1 section also of 1st p-SiOF layer also exists in a wafer even if the place whose fluorine concentration is 4.0x1021 atoms/more than cc is not the whole wafer surface, such an embodiment is also included in the range of the invention in this application. Moreover, although the 2nd p-SiOF film was limited with 4.0x1021 atoms/cc [less than] fluorine concentration, it can restrict to the field to which the 2nd p-SiOF film is all removed at CMP processing, and the film of the fluorine concentration beyond it can also be used.
[0058] the specific inductive capacity of the silicon oxide which contains the 1st fluorine by the method of this invention -- 3.3 or less -- desirable -- 3.2 or less -- it is -- the minimum -- 2.8 -- it is 2.9 preferably moreover, the specific inductive capacity of the silicon oxide containing the 2nd fluorine -- 3.3 -- exceeding -- desirable -- 3.4 or more -- it is -- the upper limit -- 4.1 -- it is 3.9 preferably
[0059] Moreover, the fluorine concentration of the silicon oxide which contains the 1st fluorine by the method of this invention is 4.0x1021 atoms/more than cc, it is a 6.0x1021 atoms/cc [more than] ratio preferably, and the upper limit is 8.0x1021 atoms/cc preferably 1.0x1022 atoms/cc.
[0060] Moreover, the fluorine concentration of the silicon oxide containing the 2nd fluorine is 2.0x1021 atoms/less than cc preferably 4.0x1021 atoms/less than cc, and the minimum is 1.0x1020 atoms/cc.
[0061] In addition, the specific inductive capacity of the silicon oxide in which the specific inductive capacity of the silicon oxide containing the 1st fluorine in this example contains 3.0 and the 2nd fluorine was 3.5.
[0062] Furthermore, in the after [blanket WCVD] examples 1 and 2, although etchback was performed, you may perform metal CMP. Moreover, you may carry out by selection W-CVD. Moreover, it is O2 because of a wettability improvement before CMP of a p-SiOF film, and CMP of the above-mentioned metal. You may perform plasma.
[0063] Moreover, p-SiOF/p-SiO2 of the 2nd example It is better for a laminating to carry out by continuation growth for a laying-under-the-ground nature improvement especially in the case of a bias high-density plasma CVD method.

[Translation done.]

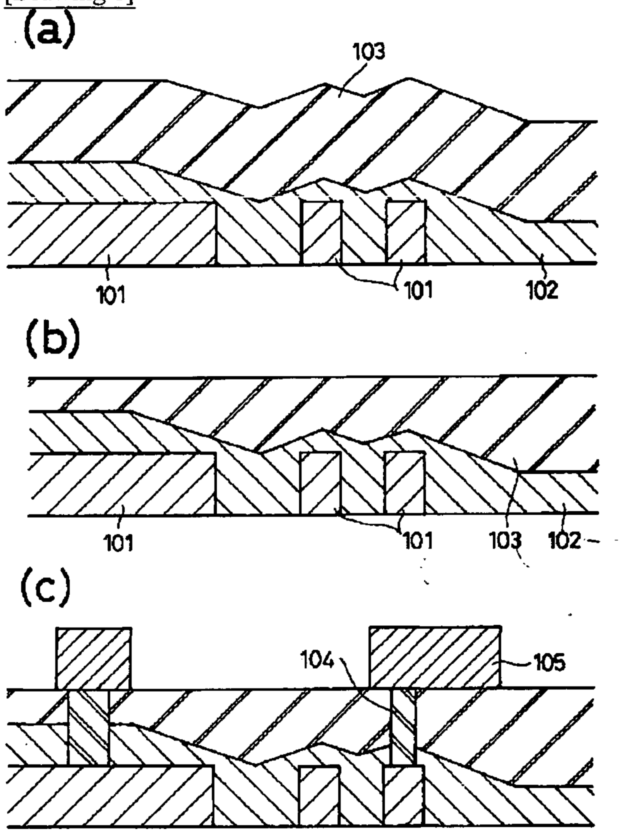
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The process-flow view of the 1st example of this invention.
[Drawing 2] The process-flow view of the 2nd example of this invention.
[Drawing 3] The process-flow view of the 1st conventional example of an experiment.
[Drawing 4] The process-flow view of the 2nd conventional example of an experiment.
[Drawing 5] Drawing showing the fluorine content of a fluorine content silicon oxide, and the inclination of a dielectric constant.
[Drawing 6] Drawing showing the fluorine content of a fluorine content silicon oxide, and a hygroscopic inclination.
[Description of Notations]
The sign used in drawing 1 - drawing 6 shows the following.
101 1st Metal
102 1st P-SiOF Film
103 2nd P-SiOF Film
104 Beer Metal
105 2nd Metal
201 1st Metal
202 1st P-SiO2 Film
203 1st P-SiOF Film
204 2nd P-SiOF Film
205 2nd P-SiO2 Film
206 Beer Metal
207 2nd Metal
301 1st Metal
302 P-SiOF Film
303 Beer Metal
304 2nd Metal
401 1st Metal
402 1st P-SiO2 Film
403 P-SiOF Film
404 2nd P-SiO2 Film
405 Beer Metal
406 2nd Metal

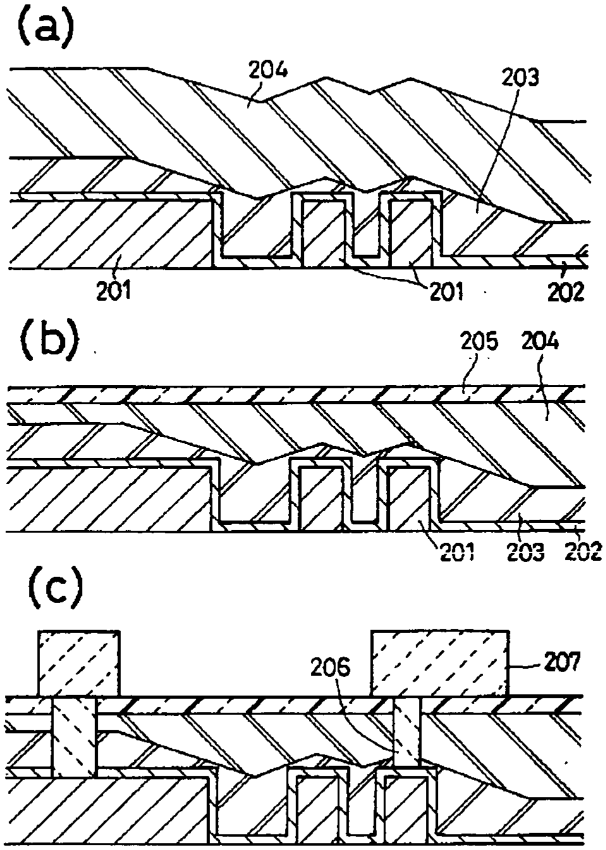
[Translation done.]

DRAWINGS

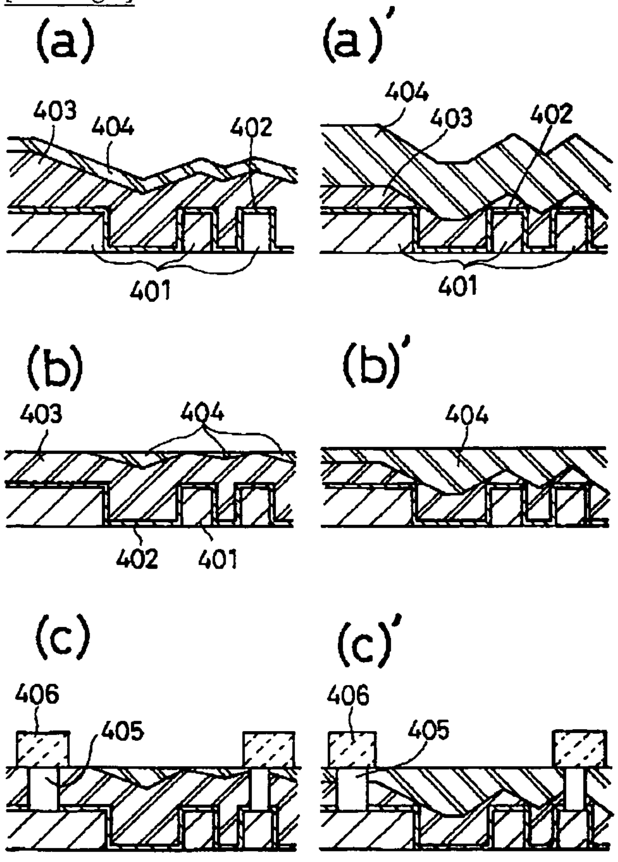
[Drawing 1]



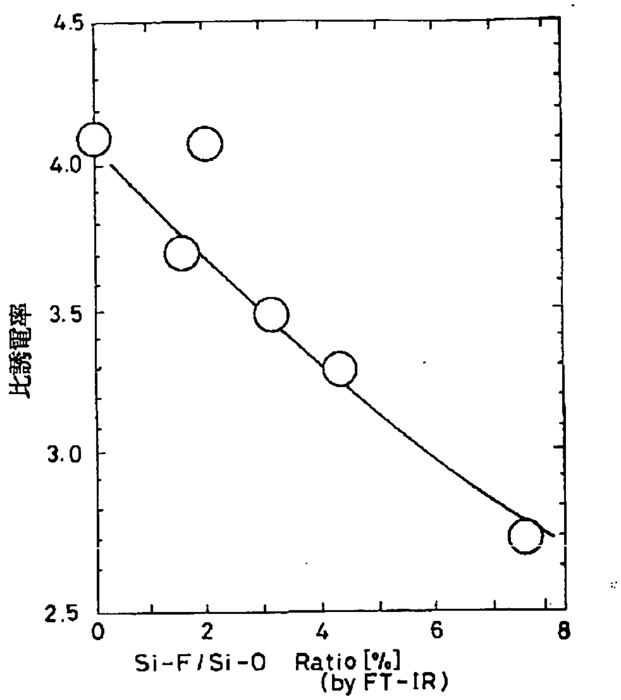
[Drawing 2]



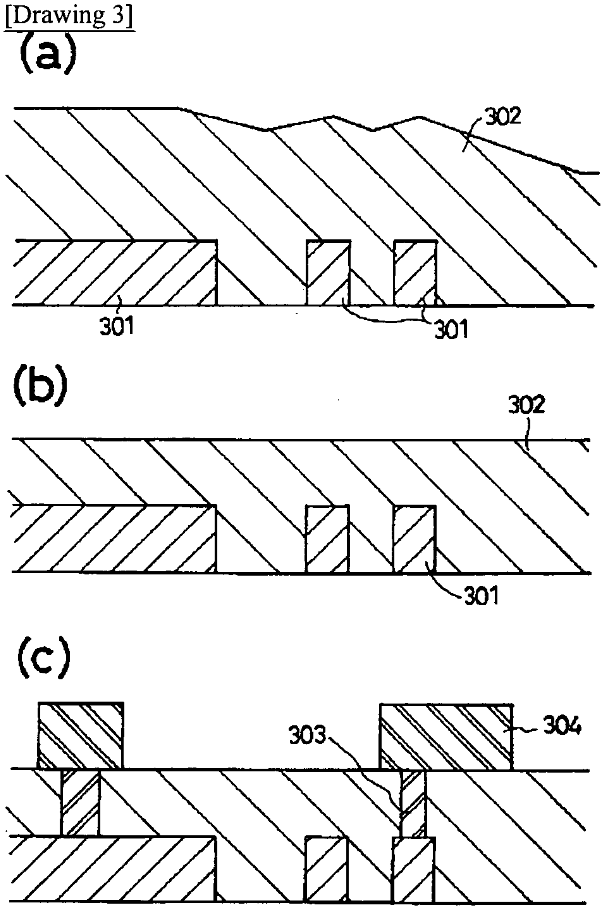
[Drawing 4]



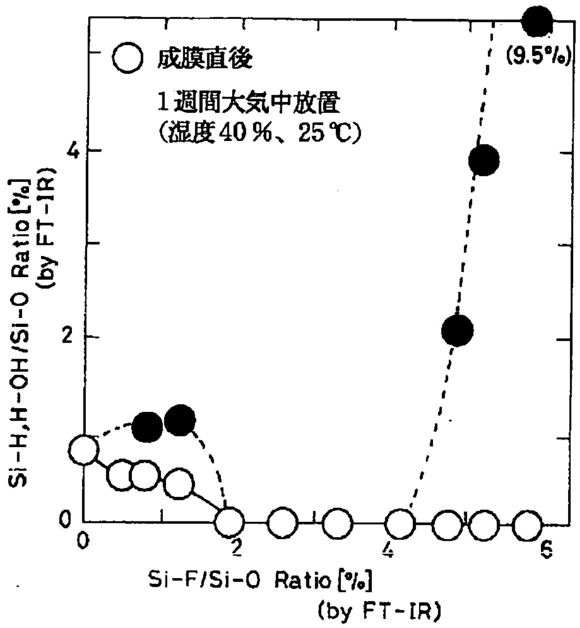
[Drawing 5]



[Drawing 3]



[Drawing 6]



[Translation done.]